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Implications of the role of storms in the global energy and water cycle

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Satellites provide an unprecedentedly dense and uniform sampling of global atmospheric variability. More than 30 years of satellite observations are now beginning to elucidate the detailed workings of the atmospheric energy and water cycle. One aspect that is becoming clearer from such dense observations is the precise role of storms in this cycle. Storms are the weather systems that produce almost all of the precipitation, yet they are relatively rare events: precipitating clouds constitute only about 10% of all clouds. Nevertheless, precipitation is the link in the global energy cycle between the solar heating (mostly) of the surface and the radiation of this energy back to space from the atmosphere. Radiative processes, even modulated by cloud variations, are much slower and larger-scale processes compared with precipitation. This mismatch of space-time scales means that the energy exchanges of the cycle do not occur at quasi-steady, quasi-balanced rates, but are intermittent in time and sparse in space. In turn, this means that the statistical behavior of the energy and water cycle variations may not respond to small climate changes in the quasi-linear way usually assumed by small-perturbation-type estimates. In fact this link in the energy and water cycle is mediated almost entirely by "extreme" events, which are currently not well-represented in climate models. Recent analysis results are used to quantify the role of storms, especially the stronger ones, in the global energy budget and to investigate the nature of the interannual variations of the distribution of storms (extreme events).